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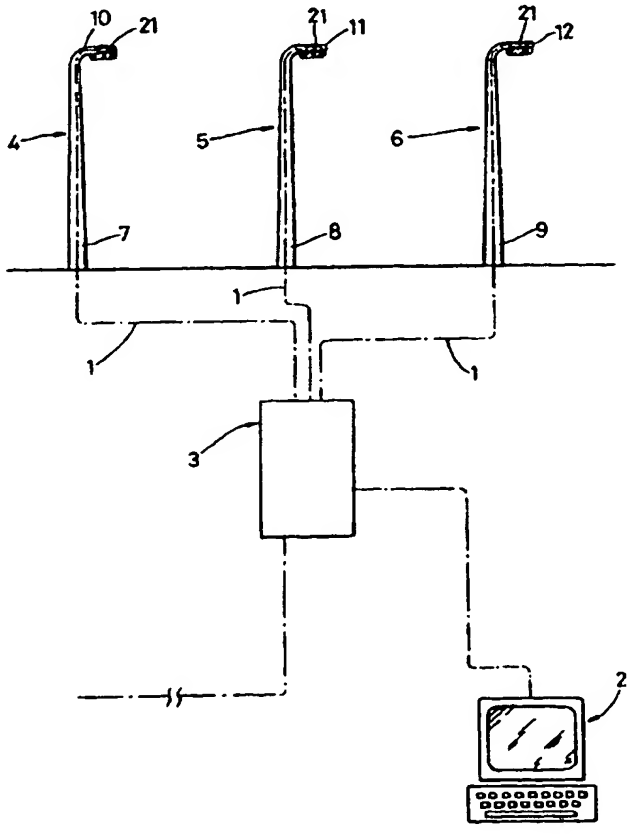
(57) Abstract

An apparatus and method for remotely monitoring the performance of an electrical appliance utilising the mains power supply cables of the electrical apparatus (4, 5, 6). A remote unit (3) is provided which communicates, using a signal at between 90 kHz and 145 kHz modulated on to the A.C. power supply cable of the electrical apparatus (4, 5, 6), with a local processing means (17) provided in the vicinity of the electrical apparatus (4, 5, 6). A memory means is provided to store information relating to the performance of the electrical apparatus (4, 5, 6). A robust communication protocol is provided to ensure that data is not lost. A control means is provided in the vicinity of the local processing means (17) so that the electrical apparatus (4, 5, 6) can be controlled via the remote unit (3). The system is primarily designed for monitoring items of street furniture (4, 5, 6).



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IMPROVEMENTS IN AND RELATING TO REMOTE MONITORING AND SIGNALLING

This invention relates to improvements in and relating to remote monitoring and signalling, especially (but not exclusively) to improvements relating to mains signalling to monitor electrical appliances such as street furniture.

Our prior application GB 2 291 993 discloses a method and apparatus of monitoring and controlling the function of electrical apparatus (in particular but not exclusively street furniture). This application adds to and improves the teachings of GB 2 291 993.

According to a first aspect of the invention we provide a housing unit comprising a housing containing an electrical apparatus adapted in use to provide a function, monitoring means adapted in use to monitor a physical parameter of the electrical apparatus, and local processing means adapted to receive a parameter signal from the monitoring means indicative of said physical parameter and output a processed parameter signal, said output parameter signal being adapted to be communicated to a remote unit, not part of said unit, which is remote from the housing.

Preferably the local processing means has at least one of the following features a) to j):-

a) the local processing means has a memory which stores data representative of the time the apparatus is operating, but not at least some other data that the local processing means monitors:

b) the local processing means is adapted to transmit signals to the remote unit on an event driven basis, transmitting upon a predetermined change in the status of said parameter, or upon receipt of a communications request;

c) the local processing means has an address which is hardware configurable;

d) the local processing means is adapted to transmit data in short bursts repeated a plurality of times in different time domains;

e) the local processing means is adapted to monitor continually the parameter status and to react to predetermined set points;

f) the local processing means is adapted to operate from a low power supply;

g) the local processing means is adapted to maintain data integrity by way of a multi-level (e.g. five level) pre-transmission/acceptance check before data transmission from the local processing means to the remote unit occurs;

h) local processing means communication is half duplex, the local processing means having the ability to transmit or receive data, but not simultaneously;

i) the local processing means unit is adapted to control loads from a remote command;

j) the local processing means has the ability to take analogue signals direct from a mains power supply to said apparatus;

Preferably the local processing means has at least 2, at least 3, or at least 4, or at least 5 of the features a) to j). The local processing means may have all of the features a) to j).

The local processing means may also have the feature h) that the local processing means is adapted to communicate digital or analogue data up to a resolution of 10 bit with an accuracy of better than + or - 1% by way of conversion of a typical analogue to digital result into single ASCII characters prior to transmission, digital interpretation taking place in the local processing means and being readable in plain English directly from the point of acquisition with no further requirement for de-coding or translation, the local processing means being adapted to be ported directly into proprietary software packaging.

The combination of the features discussed above enables us to provide a mains signalling system that has a greater range than previous systems of similar signal strength.

The invention will be described in relation to street furniture, but has wider applications. In its simplest form of one aspect of the invention street furniture such as street lamps are operated via a connection to power supply cables that feed power to a lamp post. A lamp post provides support for a light unit, or luminaire, which includes a light source. The power from the cable turns the lamp on or off.

The electrical apparatus may be a light source, adapted in use to provide light. The housing unit may be a luminaire (light unit).

It is well known that in order to ensure that an area is correctly lit by street lamps, some kind of checking needs to be performed to determine whether or not the lamps are functioning. Typical faults include a blown fuse or a faulty light source, and in the past teams of men have been employed to drive around an area looking for street lamps which are not working (and then making repairs or reporting the fault). This need for manual inspection is undesirable in many cases. For example, if a street lamp is cycling between an on state and an off state, a workman may drive past the lamp when it is in the on state, and not notice that the light is faulty.

Also some manual checkers may not be as trustworthy as desired, and many claim time for driving around inspecting lamp posts when in fact they are not. Providing a light source with monitoring means has the advantage that it is no longer necessary to employ teams of checkers as previously was the case.

This is advantageous as it enables the light unit to perform self monitoring functions and can eliminate the need for a team of workmen to monitor street lamps. By providing the monitoring means at the light units (as opposed to in the base of a lamp post) the monitoring unit may be moved safely out of the way of vandals. The provision of a self contained unit is also advantageous in that cost can be reduced when compared to a separate light unit and monitoring or control unit. When installing new lamp posts a head unit, or luminaire, has to be attached to an upright post anyway, and it costs no more in installation time to install a self-checking means signalling luminaire than a standard one. The act of wiring it up is the same.

In the light unit the local processing means receives signals from the monitoring means and sends out separate signals to the remote unit. It can therefore process the monitoring means' signals itself and does not need to transmit all of the raw, original data over substantial distances. Thus the monitoring means' signals should be less corrupted and less noisy when they are processed. Furthermore, the local processing means may send its signals to the remote unit only at certain times, for example when the remote unit is not being addressed by any other local processing means, or at regular intervals, for example every hour or once a day. The local processing means may poll the remote unit periodically and transmit its processed data signals only when it receives back a down loading signal (or vice versa, the remote unit may poll the housing unit). There is therefore no need to have continuous polling of the local processing means because it can process signals and store relevant data, for example statistical data, locally.

The local processing means may be arranged so that it monitors signals from the monitoring means continuously or at predetermined times. Similarly, the remote unit may receive signals from the local processing means continuously or at predetermined times. The local processing means (or remote unit) may only store data on signals if predetermined criteria are met. The local processing means may filter out a lot of data and not transmit information relating to all monitoring means signals to the remote unit. For example, in lamp posts most lamp failures occur in the first 30 minutes following start up of the lamp. The local processing means (or the remote unit) may record data indicative of the performance of a lamp post unit for only a predetermined time (e.g. 30 minutes) following start up of the lamp. Alternatively, or additionally, the local processing means may monitor monitoring means signals, but not record data on them (for onward transmission to the remote processor)

unless they fall outside (or within) a predetermined range or value. Alternatively, the remote processor may receive signals but not record them if they are outside (or within) a predetermined range or value.

For example, a lamp post has a normal operating state. The monitoring means could be set up to ignore signals that are at the normal level, or within an allowable deviation of "normal". If the monitoring means was looking at the voltage across a particular resistor in the lamp post it might ignore signals that are within the range of, say, 5V $\pm$0.5V (a 20% band of tolerance). If signals fall outside of an allowable range the local processing means records information relating to them and in due course sends signals to the remote unit. Instead of waiting for its normal polling time the local processing means may be set up to poll the remote unit as soon as an unacceptable signal has been received, or when it determines that the out-of-range sensor signal is not an error. The local processing means preferably processes a plurality of monitoring means signals that it receives and dependant upon these monitoring means' signals the local processing means preferably passes on appropriate signals to the remote unit. Preferably the processing means processes a plurality of different physical parameters. For example it may receive and process: a) signals indication of voltage at one point; or b) voltage at a second point; or c) current at a point; or d) temperature; or e) stress or any other parameter; or f) any combination of a) to f).

The remote unit may be interrogated by a user, preferably remotely interrogated.

The local processing means receives signals from the remote unit via the mains power supply cables. The local processing means may operate a control unit to operate the light source (when the electrical

apparatus is a light source) between an on and an off state. This may be in response to signals transmitted down the mains power supply cables. The local processing means may also be adapted to transmit signals back down the mains power supply cable to the remote unit. This has the advantage that it allows the local processing means to monitor the operation of the light source and send signals back to the remote unit to indicate a fault. It has the further advantage that the remote unit can send signals to the local processing means, and perhaps control the operation of the light source.

Up until now, it has been recognised that a stand alone control/monitoring signal processing unit may be provided. In particular the control/monitoring/signal processing unit has been provided in a form suitable for incorporating into the base of a street lamp, other lamp support or other electrical apparatus. This unit is then retro fitted to a standard electrical apparatus, perhaps a street lamp. Such systems are well suited to retro-fit applications in which the standard control unit (perhaps at the base of a street lamp post) is replaced with the new control/monitoring signal processing unit.

The light source may comprise an incandescent source, fluorescent lamp, SOX, SON, MN, or other light source.

In one embodiment, the present invention has the light source and the local processing means (and monitoring items) all in the single unit that is the luminaire. In another embodiment we may incorporate the local processing means in a cut out unit, for example that disclosed in our earlier patent application GB 2 261 116.

The local processing means may transmit one or more signals representative of the parameter signal of the remote unit. This has the advantage of alerting the remote unit to the various physical parameters being monitored.

Most preferably, the housing houses the control unit. This has the same advantages as having the other components in the housing; easier to install, remove from the reach of vandals, etc.

The local processing means may be adapted to receive signals via the mains power supply that provides power to the light source, and in response to the signals operate the light source. This may make the light source easy to control and monitor.

The housing unit may also include a visual indicating means. The indicating means may be adapted to produce a visual output signal representative of a physical parameter of the light source (or other electrical apparatus). For example, the visual indicating means may comprise an LED which is illuminated when the lamp should be on. This has the advantage that it makes it easier to see if there is a fault; if the LED is on but the light source is not then there is a fault, whereas if the lamp is merely not on, it is not apparent whether there is a fault.

The visual indicating means may also be adapted to indicate when the remote unit is communicating with the local processing means (or vice versa). This is advantageous when trying to find faults in the system: it is immediately apparent if there is a breakdown in communications - the visual indicating means will not indicate communication taking place.

The monitoring means may be adapted to monitor the mains voltage at the light source before and/or after the light source is lit. The monitoring means may also be adapted to monitor the voltage at the light source before and after a fuse provided to protect the light source. The monitoring means may also be adapted to monitor the current flowing through the light source. The monitoring means may comprise a plurality of sensors, each sensor being adapted to sense a different parameter of the light source. Preferably, the sensors may include a current sensor and a voltage sensor adapted to measure the current passing through and the voltage supplied to the lamp (or other electrical apparatus). Providing sensors/monitoring means to detect the above mentioned parameters is advantageous in that it possible to ascertain the correct functions of the light source (or other electrical apparatus).

Preferably the monitoring means adapted to monitor current can measure load currents in the range 8w to 1.2kw. This may be user configurable. Preferably the light unit has an operating voltage of between 80 and 260 volts A.C.

Preferably the light unit is provided with input surge protection to B.S.I class B (6kv 1.2 x 50μs). Preferably the frequency of the A.C. supply to the light unit can be in the range 45-65Hz. Most preferably the frequency of the A.C. supply is approximately 50Hz. Providing a light unit which can operate under these conditions is advantageous because it allows the unit to be used in typical conditions encountered in the market place. The unit may be also able to be used in a number of countries/areas if such a range of inputs is allowed.

The local processing means or the remote unit may be able to monitor the time the light source is on: that is emitting light. This is

advantageous as it allows a company/body operating the light unit to ascertain whether the light sources are meeting the specified number of hours before failure.

The local processing means and the remote unit may be adapted, in use, to communicate in half duplex. This may ensure robust communication of data.

It may be possible to monitor the current flowing in the light unit in a variety of ways. This may be user configurable. One such way may be to measure the total current of the light unit including that passing through a ballast, a capacitor and the light source. The user configurability is advantageous as it provides a flexible device which can meet a variety of customer requirements.

The remote unit and the local processing means may be adapted, in use, to modulate the signal present on the mains power supply cables at a carrier frequency of approximately 135kHz. This frequency may be a frequency which is relatively immune from noise.

The remote unit and the local processing means may incorporate phase locked loops (PLL) ensuring that the system can "lock on" to the carrier frequency.

We have experienced problems in installations with long cable lengths in which there is a voltage drop along the mains power supply cables. This may have a disastrous effect on reliable communications, and providing the PLL's can overcome this problem.

The remote unit may be provided with a memory means. The memory means may record signals sent to the remote unit from the local processing means. This has the advantage that a history of operation of the light unit (or other electrical equipment when the invention is applied to something other than a light unit) may be built up which can be reviewed to inspect how the light unit is functioning.

The memory means may be approximately 8 kilobytes. Alternatively in an improved version the memory means may be approximately 16 kilobytes. These sizes may provide convenient memory means, large enough to store a reasonable amount of data.

Preferably the local processing means is a microcontroller.

Preferably the microcontroller is provided encased in a matrix, such as a resin block. This protects the assembly of the microcontroller and associated conversion circuitry. Hitherto it has been unthinkable in such a high volume product as a monitor or a control unit for street furniture to encase a microcontroller assembly in a protective matrix. If anything goes wrong with the associated, and cheap, electronics which accompanies a microprocessor chip it is conventional to take the board upon which the microcontroller and associated circuitry are mounted out of the apparatus and see if the board can be repaired. By encasing the assembly in a matrix there is no possibility of repair. This means that a £2-£3 microcontroller could be made useless by the failure of a 1 penny resistor. Up until now this has meant that microcontrollers, at least in high volume, cost conscious, products have not been encapsulated in resin. By using commercially available microcontrollers they can be disposable. Indeed, another way of looking at this aspect of the invention is as a one-shot disposable monitor assembly that incorporates a

microcontroller and associated electronic circuitry encased in a matrix, adapted to monitor and process signals from an electrical apparatus.

By having a microcontroller, instead of a microprocessor we may be able to make our monitoring apparatus far smaller than would otherwise be the case.

Another problem associated with monitoring of a large number of electrical devices, such as lamp posts, is that the end user needs to know which unit is showing a problem (so that he can send someone to repair the device). Each device (or group of devices) therefore needs to indicate its own identity. Conventionally this is done by having a slightly differently encoded microchip for each local monitoring device. The local monitoring unit associated with each lamp post codes its signals so that the remote can identify it, and knows to which lamp post the signals relate. This is all very well until the microchip in a local monitor fails. In order to replace the microchips the engineer must contact the manufacturers of the microchips, give them the identity code of the broken microchip and ask them to encode, on a one-off basis, another microchip with the same identify code (so that the remote processor will still associate the signals with the correct lamp post). The engineer must then wait for the replacement part to arrive and then go out and fit it. Thus the engineer usually makes two trips to the lamp post (one to determine that it is the chip that is at fault and a second to fit the replacement chip) and typically has to wait three weeks or so for the replacement chip to arrive.

Preferably the local processing means is provided with an identity code unit, the arrangement being such that the identity code unit can be

removed from the local processing means and can be re-used with a new local processing means.

This enables us to make all of the local processing means of our light units identical, without the need to give them an identity code. This reduces their unit cost. Furthermore, since the local processing means are identical if one fails on-site an engineer can carry a spare local processing means with them to the electrical device and can replace it there and then taking out the identity code unit from the old light unit and attaching it to the new local processing means so as to create a new light unit, but with the same code unit.

The code unit may be considered to be a coding key. In an even more preferred arrangement the identity code unit comprises a plurality of coupling members adapted to co-operate with a plurality of complementary coupling members provided on the local processing means, the arrangement being such that when the code unit is mounted on the local processing means electrical connection is made between certain complementary coupling members, dependant upon the configuration of the code unit.

Instead of requiring electrical connection to provide the code any suitable interaction may be used (e.g., optical coding). The local processing means must simply produce a code signal dependant upon the code unit.

Preferably the code unit has a plurality of wires linking parts of its coupling members. If that is all the electrical content of the code unit there is very little to go wrong with it, which means the engineer will hardly ever have to replace a broken code unit.

Preferably to code the proto-code unit the user, in use, makes, or more preferably breaks, one or more connections between pairs of coupling members of the code unit. For example, the proto-code unit may be provided with 8 wires linking 8 pairs of coupling members. The engineer may have a broken code unit which he knows (from his own records) originally had linking wires nos. 1,6, and 7 broken, and linking wires nos. 2,3,4,5, and 8 intact. He therefore takes the proto-code unit and codes it to the same code as the original code unit by breaking wires 1,6, and 7 with an appropriate tool such as a small screwdriver. Alternatively manually operable switches may be provided to make or brake the connections.

The remote unit may be adapted to receive signals from a plurality of said local processing means.

Preferably there is a housing unit which comprises connection means adapted, in use, to co-operate with a complementary mounting means. The mounting means may be associated with a post (perhaps a lamp post) or other similar structure. The connection means may allow a user to attach the housing unit to a mounting relatively easily.

Most preferably, electrical coupling means are provided which are adapted to be connected to an electrical supply means of the post (or other similar structure). Such an electrical coupling means may allow the user to simply attach a housing unit to a mounting, connect a power supply, and so provide a piece of electrical apparatus capable of being monitored/controlled via its mains power supply wiring.

According to a second aspect of the invention we provide a method of allowing remote monitoring of an electrical apparatus to occur, comprising providing a housing means containing an electrical apparatus, a processing means and a monitoring means and causing the monitoring means to monitor at least one physical parameter of the electrical apparatus and output a parameter signal representative of the physical parameter to the processing means and further causing the processing means to communicate the processed parameter signal to a remote unit which is remote from the housing means.

Preferably the method comprises having the local processing means - remote sensor interface doing one or more of the following:

a) the local processing means monitors signals representative of said parameter, but does not store all of the data it is fed by the sensor, but does store at the local processing means data relating to the time that the electrical apparatus has been operating,

b) the local processing means transmitting temporarily stored data to said remote sensor on an event driven basis, transmitting upon a change of the monitored parameter, or upon a communications request from the remote unit;

c) the data transmission from the local processing means to the remote unit being sent in a plurality of (e.g three) short bursts in different time domain;

d) the local processing means continually monitoring its own parameter status and reacting as its parameters reach or pass predetermined set points;

e) data integrity of the data transmitted from the local processing means to the remote unit is maintained by way of a multi-level pre-transmission/acceptance check comprising one or more of f) to i);

f) ensuring that the receive signal is continually present for a minimum time (e.g 100 milliseconds);

g) ensuring that the first bit is a particular ASCII character which initialises all receive buffers of the local processing means;

h) ensuring that the next bits of information received by the local processing means identify its address;

i) ensuring that the next bits of information contain a predetermined ASCII character and a command digit.

j) ensuring that the data stream received by the remote sensor is at a predetermined speed (e.g 300 baud), any extra or non ASCII characters re-setting the receive buffer of the remote unit to zero and requiring repeat transmission;

k) and in which method the local processing means and remote unit have the ability to communicate digital or analogue data up to a resolution of 10 bit with an accuracy of better than + or - 1% by way of conversion of a typical A to D result into single ASCII characters prior to transmission, digital interpretation taking place in the local processing means and being capable of being read in plain English directly from the point of acquisition with no further requirement for de-coding or translation, so that the data is adapted to be ported directly into proprietary software packaging;

l) and in which local processing means communication with the remote unit is half duplex, each unit having the ability to transmit or receive data but not simultaneously allowing the Scout unit to control loads from a remote command;

m) and the local processing means having the ability to take analogue signals direct from the mains power supply of the electrical apparatus, and

n) in which the local processing means provides an analogue R.M.S. reading of load current passing through said electrical apparatus.

Preferably the method comprises doing 2, 3, 4, 5, 6, 7 or more, or all of a) to n).

Providing a stand alone housing which contains the electrical apparatus has the advantage that it provides a safe and secure way of housing the electrical apparatus, the monitoring means and the local processing means.

The electrical apparatus may be a light source adapted to produce light in use. The housing may be a luminaire.

Preferably the method is a way of monitoring, remotely, street furniture, perhaps street lamps.

Preferably the method comprises connecting the housing means of the electrical apparatus to mounting means (e.g. lamp posts) which have already been provided. This may provide a cheap efficient way of connecting electrical apparatus (e.g. street lamps) which have the ability to be monitored.

The method may further comprise providing a housing unit which simply needs to be connected to mains power supply cables in order to provide a working electrical apparatus (e.g. a street lamp) with the ability to be remotely monitored. Not only may such a method provide a cheap efficient way of providing an electrical apparatus (e.g. a street lamp) which can be remotely monitored, it positions the expensive monitoring, and local processing means out of the reach of vandals. (These are positioned in the housing means which may be 10m above street level).

The method may allow a number of electrical apparatus to be monitored by a single remote unit. This has the advantage that it is much more efficient than providing a single remote unit for each piece of electrical apparatus being monitored.

The method may comprise modifying the signal present on the mains power supply cables to allow the local processing means to communicate with the remote unit. This may provide a simple way to provide communication.

The local processing means of a first piece of electrical apparatus may monitor the signal on the mains power supply cable to ensure the local processing means on a different (second) piece of electrical apparatus monitored by the same remote unit as the first piece of electrical apparatus is not communicating with the remote unit (or the remote unit is not communicating with the second piece of electrical apparatus) when the local processing means of the first piece of electrical apparatus communicates with the remote unit. This may ensure that signals are not lost due to two local processing means attempting to communicate with the remote unit.

The method may further comprise providing control means in the electrical apparatus, which can be controlled by signals from the remote unit. This has the advantage that the electrical apparatus can be controlled by, as well as monitored by, the remote unit.

The remote unit may issue commands to the local processing means. These may control the local processing means and/or the control means and so operate the electrical apparatus.

58. This may allow a single command to affect a number of electrical apparatus.

Alternatively or additionally the remote unit may issue commands which effect only specific local processing means and/or control means. An advantage of this is that single pieces of electrical apparatus may be controlled.

The method may comprise issuing commands from the remote unit which activate the electrical apparatus in communication with the remote unit in sequence. For instance a row of street lamps may be turned on one after another until they are all on. An advantage of this is that input surge currents are reduced which may lead to an increased life of the electrical apparatus.

Further the remote unit may issue commands to turn off (or reduce the current to) electrical apparatus (for example street lamps) at specific times. An advantage of this is that energy consumption may be reduced.

The method may comprise sending each communication between the remote unit and the local processing means/control means (or vice versa) a number of times (preferably a plurality of times, perhaps three times). This may allow the receiving device to reconstruct a noise damaged communication from the received signals. (It is unlikely that a communication will be effected the same way by noise each time it is transmitted, and therefore different parts of the signal may be damaged. By comparing the different communications it should be possible to determine which part of the communication was damaged and maybe also to repair the damage).

The remote unit may sound an alarm when an error message is received from a local processing means. This has the advantage of alerting a user of the system that something is amiss.

According to a third aspect of the invention we provide a kit for connecting to a lamp post, the kit comprising a self-contained luminaire housing monitoring means capable of monitoring in use the operation of the lamp and communicating with a remote unit.

Noise rejection is a problem when signals are transmitted from local processors to the remote unit. Transmitting information only periodically, instead of continuously reduces the likelihood of interference between signals from different local processors. Similarly, transmitting only when the remote unit indicates that there is no other signal traffic reduces noise.

Most noise is at or around the mains frequency. We may transmit a carrier signal from a local processor to a remote unit in the kHz range, preferably at least 50kHz.

We may provide the light unit with the facility to adjust the carrier frequency. In one embodiment the mains carrier frequency is adjustable from 90-145kHz in accordance with regulatory requirements.

According to a fourth aspect of the invention we provide a method of providing a street with street lamps comprising fitting housing units according to the first aspect of the invention to lamp posts already in situ.

According to a fifth aspect of the invention we provide an item of street furniture (for example a lamp post) comprising a post, or other

support structure, and a housing unit, or luminaire, in accordance with the first aspect of the invention.

According to a sixth aspect of the invention we provide a system comprising a plurality of lamp posts (or other street furniture) having a housing unit in accordance with the first aspect of the invention and a remote unit adapted, in use, to receive signals from local processing means of said units.

Preferably the system is adapted, in use, to control the operation of the electrical apparatus of the items of street furniture.

According to a seventh aspect of the invention we provide monitoring apparatus for monitoring electrical apparatus comprising a sensor to monitor a parameter of the electrical apparatus, a local processing means and a remote unit geographically separate from the electrical apparatus in which the local processing unit is adapted to process signals from the sensor and transmit its own signals to the remote unit.

According to an eighth aspect of the invention we provide a method of remote monitoring of an electrical apparatus, the method comprising providing a sensor to monitor a parameter of the electrical apparatus, providing a remote unit geographically separate from the electrical apparatus, at which a user can obtain information about the electrical apparatus, and further comprising providing a local processing means at the electrical apparatus, the local processing means processing the signals from the sensor before it transmits its own signals to the remote unit.

Some of the embodiments of the invention contain the feature of a housing containing the monitoring apparatus and the function-providing electrical apparatus (e.g. the light source) while other embodiments do not. It will be realised by the man skilled in the art that the features of those embodiments containing the housing which do not relate to the housing are equally applicable to the embodiments of the invention not containing the feature of the housing.

Embodiments of the invention will now be described by way of example and with reference to the accompanying drawings of which:-

Figure 1 shows schematically a system for monitoring and controlling the operation of a number of street lights.;

Figure 2 indicates schematically a carrier signal at a far higher frequency than noise.

Figure 3 schematically shows a polymer block encapsulating a microcontroller and associated electronics circuiting, and having a demountable identity code key;

Figure 4 shows in more detail the identity code key of Figure 3;

Figure 5 shows a monitoring system;

Figure 6 shows a schematic of a light unit in accordance with the invention;

Figure 7 shows an isometric view of a housing means suitable for use with a street lamp; and

Figure 8 shows a detailed view of a remote unit 3.

Figure 1 shows a plan view of a preferred embodiment of a monitoring system for light units. The system comprises a master control unit 2 which is connected to one or more remote units 3. Each remote unit controls the operation of one or more street lamps 4,5,6. Each street lamp comprises a lamp post 7,8,9 and a housing means 10,11,12 (commonly referred to as a luminaire). The street lamps 4,5,6 are supplied with electricity by mains power supply cables 1.

The housing means 10,11,12 is shown in more detail in Figure 7. The housing means comprises a light source 13 and associated starter circuit 14, a monitoring means 15 and control means 16. A local processing means 17 is also provided. The housing means 10,11,12 contains all the necessary apparatus for running the light source contained within. The monitoring means 15 comprises a plurality of sensors. Figure 8 shows an overall view of a typical housing means 10.

In use, the remote unit 3 sends out a power-up signal to the local processing means 17 over the mains power supply line 1. This signal is received by the local processing means 17 within the housing means. The local processing means then switches on and waits for a set period, perhaps three minutes after it switches on before sending a signal back to the remote unit 3 to record its operation or status. Thus, when a remote unit 3 is connected to a plurality of street lamps 4,5,6, the remote unit will receive a series of status signals. Only those signals indicating a fault condition are stored in a memory provided in the remote unit (not shown) i.e. the fault/error signals are logged. The time at which the fault

signals were received, and which street lamp issued the fault signal are also recorded.

After the reply signals have been sent to the remote unit 3, the local processing means 17 at the street lamp awaits further instruction. At this point the street lamps 4,5,6 are not yet on.

The remote unit 3 may contain a photocell which measures when the street lamps 4,5,6 need to be turned on, or alternatively, a control signal issued by the main controller 5 can be used to decide when the street lamps 4,5,6 are to be turned on. In either case, when the lamps are required to be turned on, the remote unit 3 issues a light source 13 "on" signal to the local processing means at each street lamp 4,5,6. This is done in sequence to avoid a large spike being generated. The local processing means 17 and the control means 16 at each street lamp 4,5,6 will then switch the lamp on. A predetermined period is allowed to elapse, say 10 minutes, in order to allow the light source 13 to warm up to its correct operating temperature. Once this time has elapsed, the processing means 17 at each street lamp 4,5,6 then sends further signals back over the mains power supply cables 1. The signals are obtained by processing parameter signals generated by the monitoring means 15. The monitoring means 15 are adapted to measure the actual physical status of the lamp. For example, the monitoring means 15 may include sensors for measuring lamp current, and lamp voltage.

Once the light source 13 is on, and has reached equilibrium (i.e. the parameters do not fluctuate substantially) the local processing means 17 sends a signal back to the remote unit 3 in the event that one of the parameters changes. This may indicate that a fault has occurred in the street lamp 4,5,6.

The housing means may also incorporate means (perhaps the control means) for controlling the light output. This may then switch the light source 13 between full output and a dimmer output in response to a signal sent from the remote unit 3 to the local processing means 17. As an example, dimming may be such that the output current is reduced by 50% which results in a 35% saving in power. This results in a significant saving when a large number of street lamps 4,5,6 are provided. We may for example want to turn lights to their dim setting after a watershed time at night (e.g. 1.00am).

Because each street lamp 4,5,6, is individually controlled by the remote unit 3, it is possible to selectively dim one or more of a set of street lamps 4,5,6 provided at each remote unit 3, or even selectively turn some off.

The light control system unit described above is advantageous in that it is event driven. A signal is only sent back to the remote unit 3 and logged if it is an error signal. One particular case of interest is when a street lamp 4,5,6 continually switches between an ON and an on OFF state. This may occur if there is a fault in the street lamp 4,5,6. In this case, it is possible to cause the local processing means in the housing means to monitor the fault signal, and if more than a given number of fault signals occur within a predetermined period of time, the local processing means 17 may send an error signal to the remote unit 3 and shut down the particular, faulty, street lamp 4,5,6 until it is repaired.

The signals sent back to the remote unit 3 provide for many possible improvements over the prior art method of monitoring street lamps. For example, the local processing means 17 may send a signal to

the remote unit 3 indicating when a light source 13 actually turns on and when it actually turns off. The amount of time that a light source 13 is on is then recorded, and a cumulative total can be built up which is representative of the "burn time" of the light source 13. This is only possible by using the monitoring means which measures the actual amount of time a light source 13 is on, as distinct from the amount of time a light source 13 is instructed to be on. Obviously, the control means 16 in the housing means may have switched a light source 13 on, but if the light source 13 is not monitored to check that it is operating, a correct check of light source 13 "burn time" cannot be made.

By monitoring the actual "burn time" of the light source 13 before failure, street lamp 4,5,6 providers can then ask for a refund or may complain if a light source 13 does not burn for the correct number of hours before failure, for example if lamps are warranted to last for 5,000 hours yet they only last 4,000 hours.

Because individual street lamp 4,5,6 control is provided, an override can be provided for individual lamps 4,5,6. For example, to meet safety codes, street lamps 4,5,6 at major junctions and roundabouts must be fully illuminated at all times. However, it is desirable to dim street lamps 4,5,6 during periods of low road use to reduce power consumption (e.g. after midnight). Using this control method, a remote unit 3 may switch some street lamps 4,5,6 to dim (or to turn off) yet retain some at full power.

The housing means may also include a visual indicating means in the form of a set of LED's 18,19,20. The LED's 18,19,20 are illuminated in response to the output signals from the local processing means 17 provided with the housing means, or may be operated by

sensors remote from the housing means. A first LED 18 shows that the light source contactors are switched ON, the second LED 19 shows that the light source is dimmed, and the third LED 20 shows that the light source is fully on. The LED's 18,19,20 can be used by maintenance staff to determine if the street lamp 4,5,6 is operating correctly.

A number of diagnostic tools may also be provided with this street lamp monitoring system. The remote unit 3 may send a test signal to the local processing means 17, and the local processing means 17 may also be adapted to send a status check signal back to the remote unit 3 in response to this test signal. In this way, the integrity of the system can be checked.

Also, the ability to measure the actual status of the street lamp 4,5,6 in real time provides several additional operational advantages. Because the remote unit 3 can record the time in which signals are received and logged, the efficiency of repair work can be checked. In one example, where three street lamps 4,5,6 in a row on a motorway are all at fault, repairs must be carried out within two hours of the fault occurring. This is known as a category one fault as it represents a severe hazard. After the repair has been carried out, the local processing means 17 at the street lamp 4,5,6 will send a signal back to the remote unit 3 indicating that the street lamp 4,5,6 is now functioning, and the time that this signal is received can be logged. Thus it is possible to check that repair work is carried out in the correct time. For example, with street lighting, the replacement of lights and general repair work is usually contracted out by the provider of the street lamps and so this system allows the street lamp provider to penalise the contractors if standards are not met.

It is also possible to provide a remote link between to the remote unit 3 or the master control unit 2. This may be via a modem so that an operator can interrogate the data logged at the remote unit 3 at any time from anywhere he or she wishes, i.e. a main control office in a central location.

To summarise, we provide a self monitoring light unit for use with a street lamp 4,5,6 or any other suitable mounting. Importantly, the housing means is self contained and incorporates its own monitoring means 15. This monitoring means 15 senses a parameter such as the current or voltage at the light and may sense when a fault occurs. There may also be provided all the control means 16 and local processing means 17 required to implement a complete remote street lamp 4,5,6 monitoring system suitable for remote interrogation over a mains power supply cable 1. This system brings with it cost savings over providing a separate housing and processing/control unit such as has been provided in the past. Also, it offers the beneficial feature of being easy to install and more secure from vandalism than prior art systems. Previously systems allowing a street lamp to be remotely monitored have been fitted at the base of lamp posts 7,8,9 once all the lamp posts have been erected and wired up. This is a separate operation and is not as attractive as simply fixing the head of a lamp post to its pole or post.

Possibly a further way of looking at the invention is to provide a housing unit, or luminaire, which can be used to provide relatively easily an item of street furniture (which can be monitored).

The user is provided with a unit which simply needs to be connected to a power supply, and mounted in an appropriate manner, to provide a working item of street furniture.

For instance if the item of street furniture were a street lamp the user may be provided with a luminaire which simply needs connecting to a lamp post and an electricity supply connected.

The monitoring means 15, the control means 16 and the local processing means 17 may be provided in a single module 21 which can be seen in Figure 3. Each module 21 comprises a microcontroller 30, an associated conversion circuit 31, and an identifying circuit 32 embedded in the epoxy resin block 33. A variety of input sensors S1, S2, S3 monitor suitable physical characteristics in the electronic circuit of the lamp post, for example S1 might monitor the voltage of a certain point, S2 might monitor the current at a certain point and S3 might monitor the voltage at another point, and so on. The sensors S1, S2 and S3 measure signals S1, S2 and S3 respectively.

The microcontroller 30 is a commercially available microcontroller which is designed for a specific purpose - which is probably other than monitoring a lamp post. However, by an appropriate choice of conversion circuit 31 we can enable the microcontroller 30 to take the input signals S1, S2, S3 and monitor them, instead of those signals which it was originally designed to monitor.

Microcontroller 30 emits its own report signals back down the power supply line, to the remote unit 3. The microcontroller has a memory (not shown) and is programmed by the remote unit 3 to report in a desired way. For example, in this particular embodiment, the remote unit 3 programs the microcontroller so that it records in its memory the performance, at 5 second intervals, of signals S1 to S3 for the first 30 minutes of the operation of the lamp post and then stops recording them

(because we believe that most lamp failures occur during the first 30 minutes following start up of a lamp). The microcontroller then polls the remote unit 3 to ask for permission to down load its memory to the remote unit 3. If the remote unit 3 sees that there is no other signal traffic then the microcontroller 30 sends out a carrier signal at, say, 135kHz (schematically shown in Figure 2) and dumps its acquired date to the remote unit 3.

The microcontroller 30 identifies itself by including in the transmitted data an identifying code.

The identifying code is generated by the identifying circuit 32, and relies upon the configuration of a code key 34.

The code key 34, shown in Figure 3, is removable from the resin block 33 and has 16 pins (8 sets of pairs) which are received in complementary holes 36 provided in the resin block. The key 34 is also shown in more detail in Figure 4, and has 8 slots 37 in its back to enable a thin tool to be inserted into the slots 37. Behind the slots 37 are, in its original, unencoded state, respective wires 38 linking pairs of pins 35. The key 34 is encoded by breaking, or not breaking, particular wires by pushing the tool through the slots 37. In Figure 4 starting from the top, wires 4,5, and 6 have been broken, leaving wires 1,2,3,5, and 8 intact which provides the key 34 with a binary code (in this example 8 bit). Each local processing means has its own, individual, and unique, coded key. It will be appreciated with an 8 bit key code we can handle 255 units on a single conductor. This could easily be upgraded to 1000 units or more simply by adding two or more bits. Instead of breaking wires on an identity key the user may manipulate switches to give it an identity.

It will be appreciated that the keys have a hardware link only, and there is no need to programme the keys at the point of installation.

The individual local processing means 17 provided in the street lamps 4,5,6 are also programmed by the remote unit 3 to keep a record of any signals which are outside of an allowable range. Although the signals S1 to S3 are recorded as a matter of course in the memory of the microcontroller 30 for the first 30 minutes, and not thereafter (as a matter of course), the microcontroller is programmed to monitor the signals continuously (say at 5 second intervals) and to keep a record of signals which are outside of an allowable error band. The microcontroller 30 may also be set up to transmit such unusual signals to the remote unit 3 periodically, or even substantially immediately (when the polling enquiry receives instructions to proceed).

It will be appreciated that the remote unit 3 could be arranged to vary the operational conduct of the microcontroller 30, for example, the master control unit 2 could be used to tell the remote unit 3 to change the period of sampling of the signals from once every 5 seconds to once every 10 seconds, or ten times a second, or any other period. Similarly, the initial recording period could be varied.

It will be appreciated that because a microcontroller is a powerful tool it can simply be reprogrammed once by the master control unit 2 and then left alone to get on with the job of monitoring/reporting. Because so much processing is done at the local processing means 17, the volume of signal traffic to the remote unit 3, and to the master control unit 2 is kept low, and this avoids confusion between the signals.

It will be appreciated that one of the benefits of the present system is that each of the blocks 33, and each of the microprocessors 30, is identical (or substantially identical). This means that we can mass produce the blocks 33 and use some and store some conveniently. If there is then a problem with one of the blocks 33 an engineer can take a replacement from our store and visit the lamp post that is having trouble (as detected by the remote unit 3, and as interrogated by the master control unit 2). He can then simply unplug the key 34, disconnect the broken base unit of the resin block 33 and exchange it for a new base unit resin block 33, and reconnect the same key 34 to the new resin block. This will guarantee that the new resin block will generate the same identity signal (since the identity signal is generated in response to the configuration of the key 34) and the remote unit 3 will be able to correlate incoming signals with a particular lamp post. This avoids the need to have special programming of replacement chips, and reduces the down time involved in maintaining the unit.

In areas where there are special problems, for example in areas near pylons where there may be a lot of interference, we would envisage using special add-on modules to enhance particular performances of the standard resin block 33. For example, we could have a plug-in filter unit to improve the noise filtering. This may be plugged into special ports in the resin block which when provided in all resin blocks, or may be wired in in-situ.

Similarly, where there is a large distance between the items of street furniture being monitored and the remote unit 3 we could include a booster unit as a separate add-on pack.

Figure 2 also schematically illustrates another feature. The microcontroller can be programmed by the remote unit 3 to adjust the frequency of its carrier signal 40, within a range. The range shown in Figure 2 is 90kHz to 145kHz. In each case, the frequency of the carrier signal is above that of the majority of the noise 41. Although some noise is present in the frequency range 90-145kHz methods of overcoming this are discussed hereinafter.

One of the advantages of using a microcontroller, as opposed to microprocessors, is that we can have a far more powerful tool in a relatively small space. For example, we would envisage having a resin block 33 roughly 100mm x 55mm x 40mm in size. This is small enough for it to be fitted into the standard housing of a street lamp light source.

Figure 6 shows an embodiment of a monitoring system represented in a block diagrammatic form. A computer 62 running the system has dedicated software for data analysis and control. The computer 62 is connected to a monitor 64 by means of a communication link 66. Mains communication buffers 68 and 70 are provided at each end of the link 66. Buffer 68 is connected to the computer 62 by an RS232 or 488 serial link. Buffer 70 is connected to a microcontroller 72 through a decoder 74.

The communication link 66 between the two buffers 68 and 70 is a half duplex link over a mains supply. Information passes along the link 66 to or from the computer 62 on a phase locked loop carrier for data integrity. Transmission can be in a frequency band 90-145kHz as opposed to the mains which is between 40 to 60Hz. For further data integrity, an automatic error correction routine is incorporated in the software in the computer 62 to replace any bits of information which are

lost. The communication stream between the buffers 68 and 70 can be in a digital form or any other suitable form.

The monitor 64 is provided with an independent power supply 76, which can be a mains supply separate from the main supply providing the link 66.

The microcontroller 72 is fed with information concerning the operation of a piece of street furniture through a number of analogue inputs. We prefer eight analogue inputs although only four inputs 78,80,82 and 84 are shown in Figure 6. Each input 78,80,82,84 is provided with a signal conditioner 86 and an opto-isolator 88. The inputs may include signals relating to an A.C. signal (such as mains supply), a D.C. signal, other current signals, or signals representative of absolute temperature or temperature change for example atmospheric temperature or temperature change. The signal conditioners 86 scale the signal up or down to be in a range suitable for the microcontroller 72 to receive. This would be, for example, in the range 0-5V. The opto-isolators 88 provide a potential cut out in case of power surges or other signals which can harm the microcontroller 72.

The microcontroller 72 has at least three outputs. In the Figure three outputs 90,92 and 94 are shown. These may be volt free outputs for external use, pulse width modulation outputs for analogue control of external loads (for example power supply to a lamp) or standard analogue D.C. voltage outputs.

The microcontroller may be provided with a plurality of further input/output ports for monitoring and control as required. In this

embodiment two eight bit ports, making sixteen digital input/output ports can be used.

A key 96 (corresponding to key 34 in Figures 3 and 4) shown in the Figure may be plugged into or remove from the microcontroller 72. The key may have an eight or nine bit identity which represents the address of the microcontroller 72.

As has been discussed in the foregoing, the invention is not to be considered to be limited to the field of monitoring street furniture. It may be applied as a metering or control system to a diverse range of electrical devices or apparatus.

Other technical features worth noting about the mains signalling system are:

Two LED's 100,101 are provided on the module 21. Both of these LED's tell a user about the communication status of the module 21.

The LED 100 is identified as RX/TX and indicates that the module 21 is "listening" to the mains power supply cable 1 for the correct carrier frequency (135kHz). In normal use this LED 100 will tend to flicker as mains noise/spikes (usually in order of microseconds) can often briefly match the 135kHz carrier frequency. At this point, although the module 21 has found the correct frequency, a number of parameters need to be satisfied before the local processing means 17 will respond.

The 135kHz carrier frequency must be present for 100ms before the LED 101 (carrier accept LED) lights to indicate carrier accepted status and allow the module 21 to receive commands. This 100ms

duration may be transmitted from the remote unit 3 and stops the module 21 from reacting to short duration mains noise/spikes crossing the same frequency.

On receipt of a valid carrier frequency (135kHz for more than 100ms) the module 21 opens a command channel ready to receive data. This data must start with the correct address for the module 21 (set by the key 34), then the data must only contain valid ASCII characters (numbers 0-9 and capital letter A-Z). If either of these conditions are not met the unit may cancel its data buffer and returns to zero to start again.

If all of the parameters for communication are met the module 21 will response to the remote units 3 commands.

There may be provided a photodetector to sense whether a door at the base portion of the lamp post is open or closed. Obviously these doors should be closed when the lamp is in use and it is important to know if the door has inadvertently been left open so that it can be closed.

Communications between the remote unit 3 and the module 21 does not take place continuously but message over sent as short bursts.

Data received (3 times) by the remote unit 3, is checked (via software) for correct ASCII characters, and the 3 messages are filtered to make 1 correct string for display and the data log, e.g. if, due to an unexpected line noise/spike, the first data message is corrupted. Such checking will also take place in communication from the remote unit 3 to the pressing means 17.

S:000 B:00000:00:00 CH0: ♠ ♣ 0 CH1:000 CH2:000 L:U/C/O

then, because of the time difference, the second message may be -

S:000 B:♠ ♣ 00:00:00 CH0:000 CH1:000 CH2:000 L:U/C/O

and the third message may be -

S:000 B:00000:00:00 CH0:000 CH1:000 CH2:0 ♠ ♣ L:U/C/O

♠ ♣= wrong characters

The remote unit 3 removes the wrong ASCII characters and filters the 3 messages together to read the correct message -

S:000 B:00000:00:00 CH0:000 CH1:000 CH2:000 L:U/C/O

This feature is important in extremely noisy environments and has proved extremely successful, often where no other devices (time clock etc.) will work.

The remote unit 3 is provided with an internal real time clock so that the time that error messages are received from various modules 21 can be logged. The remote unit in its standard form can log 650 messages, and in an improved version can log 1300 entries.

A set of commands exists some of which are global commands which will operate all of the modules 21 in communication with the remote unit 3, and some of which are individual commands which are issued specific to module 21 in communication with the remote unit 3.

Figure 8 shows a detailed view of a remote unit 3. There is provided a reset switch 150, fuse holders 151,152,153, a series of status LED's 154,155,156,157,158,159,160 (154 indicates external power supply status: 155 indicates whether the remote unit 3 is transmitting data; 156 indicates whether external control hardware is operative: 157 indicates whether the remote unit 3 has accepted an incoming carrier signal; 158 indicates whether the communication port is receiving commands; 159 indicates whether the communication port is transmitting

commands; 160 indicates whether the communication port is in use), a mains switch 161, a bi-directional RS232 communication port (for connection to a laptop computer, serial printer, modem, etc.), an output block 163 for connection to various devices, a keypad 164 (for entering commands) and an LCD display 165 to display various massages, etc.

One function provided on the remote unit 3 may be a test to check communication with the modules 21.

An alternative to providing the key 34 to provide the identity for the local processing means 17 to provide a series of jumpers on the circuit board. The presence or absence of the jumpers will indicate the code to the local processing means 17. Switches could also be used to provide the code; the position of the switches could them indicate a 0 or a 1 much in the same way as the breaking of a wire or the presence/absence of a jumper.

In summary, in one embodiment of the invention we use a Local Processing Means (usually several of these each associated with its own electrical apparatus) that performs a function, and a remote unit that controls the local processing means and receives signals from them.

The local processing means and the remote unit preferably have the following features:-

local processing means

(a) The local processing means is only a messenger - no data is stored at point of acquisition except burn hours (for a light).

(b) Event driven basis only - transmits on parameter status change or communications request.

(c) Address is hardware configurable 8 bit.

(d) Data transmission sent in short burst three times in slightly different time domain.

(e) Continually monitors own parameter status and only reacts to predetermined set points.

(f) Only small power supply required because of intermittent operation philosophy.

(g) Data integrity is maintained by way of five level pre-transmission/acceptance check.

i The receive signal must be continually present for minimum 100 milliseconds. This reduces the effect of coincidental high frequency noise falsely triggering the unit. The signal at the correct frequency for greater than 100 milliseconds could only therefore have originated from the remote unit.

ii The first bit is a particular ASCII character which initialises all receive buffers of the local processing means on the circuit.

iii The next three bits of information must be relative to the receiving local processing means and must contain its address.

iv The next two bits of information must contain the # character (or another predetermined character) and

command digit.

v The valid data stream must be received at a speed of 300 baud and any extra or non ASCII characters will re-set the receive buffer to zero and require repeat transmission.

(h) The ability to communicate digital or analogue data up to a resolution of 10 bit with an accuracy of better than + or - 1% by way of conversion of a typical A to D result into single ASCII characters prior to transmission, unlike the standard 8 bit binary conversion. Digital interpretation takes place in the Local Processing means and can be read in plain English directly from the point of acquisition with no further requirement for de-coding or translation. It can therefore be ported directly into proprietary software packaging, e.g. MS Windows Terminal Communications Package.

(i) All local processing means communication is half duplex which means each local processing means has the ability to transmit or receive data but not simultaneously allowing the local processing means to control loads from a remote command.

(j) The ability to take analogue signals direct from the mains.

(k) True analogue R.M.S. Reading of load current.

Remote Unit

(a) All save features as in the local processing means.

(b) Ability to obtain data in the field.

(c) Ability to enter data in the field.

(d) Contains in-built software tools.

(e) LCD unit.

(f) Date and time stamps all events into log.

CLAIMS

1. A housing unit (10, 11, 12) comprising a housing containing an electrical apparatus (13) adapted, in use, to provide a function monitoring means (15) adapted, in use, to monitor a physical parameter of the electrical apparatus (13), and local processing means (17) adapted to receive a parameter signal from the monitoring means (15) indicative of said physical parameter and output a processed parameter signal, said output parameter signal being adapted to be communicated to a remote unit (3), not part of said unit (10, 11, 12), which is remote from the housing.

2. A housing unit according to claim 1 in which the local processing means (17) has all of the following features a) to j):-

a) the local processing means (17) has a memory which stores data representative of the time the apparatus is operating, but not at least some other data that the local processing means (17) monitors;

b) the local processing means (17) is adapted to transmit signals to the remote unit (3) on an event driven basis, transmitting upon a predetermined change in the status of said parameter, or upon receipt of a communications request;

c) the local processing means (17) has an address which is hardware configurable:

d) the local processing means (17) is adapted to transmit data in short bursts repeated a plurality of times in different time domains;

e) the local processing means (17) is adapted to monitor continually the parameter status and to react to predetermined set points;

f) the local processing means (17) is adapted to operate from a low power supply;

g) the local processing means (17) is adapted to maintain data integrity by way of a multi-level (e.g. five level) pre-transmission/acceptance check before data transmission from the local processing means (17) to the remote unit (3) occurs;

h) local processing means (17) communication is half duplex, the local processing means (17) having the ability to transmit or receive data, but not simultaneously;

i) the local processing means (17) is adapted to control loads from a remote command;

j) the local processing means (17) has the ability to take analogue signals direct from a mains power supply to said apparatus;

3. A housing unit according to claim 1 which the local processing means (17) has a memory which stores data representative of the time the apparatus is operating, but not at least some other data that the local processing means (17) monitors;

4. A housing unit according to claim 1 or 3 in which the local processing means (17) is adapted to transmit signals to the remote unit (3) on an event driven basis, transmitting upon a predetermined change in the status of said parameter, or upon receipt of a communications request;

5. A housing unit according to claim 1 or claims 3 to 4 in which the local processing means (17) has an address which is hardware configurable;

6. A housing unit according to claim 1 or claims 3 to 5 in which the the local processing means (17) is adapted to transmit data in short bursts repeated a plurality of times in different time domains;

7. A housing unit according to claim 1 or claims 3 to 6 in which the local processing means (17) is adapted to monitor continually the parameter status and to react to predetermined set points;

8. A housing unit according to claim 1 or claims 3 to 7 in which the local processing means (17) is adapted to operate from a low power supply;

9. A housing unit according to claim 1 or claims 3 to 8 in which the local processing means (17) is adapted to maintain data integrity by way of a multi-level (e.g. five level) pre-transmission/acceptance check before data transmission from the local processing means (17) to the remote unit (3) occurs;

10. A housing unit according to claim 1 or claims 3 to 9 in which local processing means (17) communication is half duplex, the local processing

means (17) having the ability to transmit or receive data, but not simultaneously;

11. A housing unit according to claim 1 or claims 3 to 10 in which the local processing means (17) is adapted to control loads from a remote command;

12. A housing unit according to claim 1 or claims 3 to 11 in which the local processing means (17) has the ability to take analogue signals direct from a mains power supply (1) to said apparatus;

13. A housing unit according to any preceding claim in which the local processing means (17) has the feature that the local processing means (17) is adapted to communicate digital or analogue data up to a resolution of 10 bit with an accuracy of better than + or - 1% by way of conversion of a typical analogue to digital result into single ASCII characters prior to transmission, digital interpretation taking place in the local processing means (17) and being readable in plain English directly from the point of acquisition with no further requirement for de-coding or translation, the local processing means (17) being adapted to be ported directly into proprietary software packaging.

14. A housing unit according to any preceding claim in which the local processing means (17) only sends its signals to the remote unit (3) when the remote unit (3) is not being addressed by any other local processing means (17).

15. A housing unit according to any preceding claim in which the local processing means (17) sends its signal to the remote unit (3) at regular intervals, for example every hour or once a day.

16. A housing unit according to any preceding claim in which the local processing means (17) (or the remote unit (3)) polls the remote unit (3) (or the local processing means (17)) and transmits its processed data signals only when it receives back a down loading signal.

17. A housing unit according to any preceding claim in which the local processing means (17) (or the remote unit (3)) stores data.

18. A housing unit according to claim 17 in which the local processing means (17) may monitor the monitoring means (15)' signals, but not record data on them (for onward transmission to the remote processor) unless they fall outside (or within) a predetermined range or value.

19. A housing unit according to claim 17 or claim 18 in which the local processing means (17) (or the remote unit (3)) records data indicative of the performance of an electrical apparatus (13) for only a predetermined time following start up of the electrical apparatus (13).

20. A housing unit according to any preceding claim in which the local processing means (17) processes a plurality of monitoring means (15)' signals that it receives and dependant upon these monitoring means (15) signals the local processing means (17) passes on appropriate signals to the remote unit (3).

21. A housing unit according to claim 20 in which the processing means processes a plurality of different physical parameters each of the physical parameters being represented by a separate signal from the monitoring means (15).

22. A housing unit according to any preceding claim in which the remote unit (3) can be interrogated by a user.

23. A housing unit according to claim 22 in which the remote unit (3) can be remotely interrogated by a user.

24. A housing unit according to any preceding claim in which the local processing means (17) receives signals from the remote unit (3) (and vice versa) via mains power supply cables (1) of the electrical apparatus (13).

26. A housing unit according to any preceding claim in which the local processing means (17) operates a control unit to operate the electrical apparatus (13).

27. A housing unit according to claim 26 in which the control unit is housed in the housing unit.

28. A housing unit according to any preceding claim in which the housing unit includes visual indication means adapted to produce a visual output signal representative of a physical parameter of the electrical apparatus (13).

29. A housing unit according to claim 28 in which the visual indication means is adapted to indicate when the remote unit (3) is communicating with the local processing means (17) (or vice versa).

30. A housing unit according to any preceding claim in which the monitoring means (15) is adapted to monitor the voltage at the electrical

apparatus (13) before and/or after the electrical apparatus (13) is energised.

31. A housing unit according to any preceding claim in which the monitoring means (15) is adapted to monitor the current flowing through the electrical apparatus (13).

32. A housing unit according to any preceding claim in which the monitoring means (15) is adapted, in use, to measure load currents in the range of 8w to 1.2kw.

33. A housing unit according to any preceding claim in which the electrical apparatus (13) has an operating voltage of between 80 and 260 volts A.C.

34. A housing unit according to any preceding claim which is provided with surge protection to B.S.I. class B (6kv 1.2 x 50μs).

35. A housing unit according to any preceding claim in which the frequency of a mains supply for the electrical apparatus (13) is in the range of 45-65Hz.

36. A housing unit according to claim 35 in which the frequency of the mains supply for the electrical apparatus (13) is substantially 50Hz.

37. A housing unit according to any preceding claim in which the local processing means (17) is able to monitor the amount of time that the electrical apparatus (13) is operational.

38. A housing unit according to any preceding claim in which the local processing means (17) is adapted, in use, to modulate the signal present on the mains power supply cables (1) at a carrier frequency of substantially 135kHz

39. A housing unit according to any preceding claim in which the remote unit (3) and/ or the local processing means (17) incorporate phase locked loops.

40. A housing unit according to any preceding claim in which the local processing means (17) is a microcontroller (30).

41. A housing unit according to claim 40 in which the microcontroller (30) is encased in a matrix such as a resin block.

42. A housing unit according to any preceding claim in which the local processing means (17) is provided with an identity code unit (34), the arrangement being such that the identity code unit (34) can be removed from the local processing means (17) and can be re-used with a new local processing means (17).

43. A housing unit according to any preceding claim in which the identity code unit (34) comprises a plurality of coupling members adapted to co-operate with a plurality of complementary coupling members provided on the local processing means (17), the arrangement being such that when the code unit (34) is mounted on the local processing means (17) electrical connection is made between certain complementary coupling members, dependant upon the configuration of the code unit (34).

44. A housing unit according to claim 43 in which the code unit (34) has a plurality of wires linking parts of its coupling members.

45. A housing unit according to any preceding claim in which the remote unit (3) is adapted in use to receive signals from a plurality of said local processing means (17).

46. A housing unit according to any preceding claim in which the housing unit is adapted, in use, to co-operate with a complementary mounting means.

47. A housing unit according to claim 46 in which electrical coupling means are provided which are adapted to be connected to an electrical supply means (1) of the mounting means.

48. A housing unit according to any preceding claim in which the electrical apparatus (13) is a light source adapted, in use, to provide light.

49. A housing unit according to any preceding claim in which the housing unit is a luminaire (light unit).

50. A method of allowing remote monitoring of an electrical apparatus (13) to occur, comprising providing a housing means containing an electrical apparatus (13), a processing means and a monitoring means (15) and causing the monitoring means (15) to monitor at least one physical parameter of the electrical apparatus (13) and output a parameter signal representative of the physical parameter to the processing means and further causing the processing means to communicate the processed parameter signal to a remote unit (3) which is remote from the housing means.

51. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 comprising having the local processing means (17) - remote sensor inteface including all of the following features a) to n):

a) the local processing means (17) monitors signals representative of said parameter, but does not store all of the data it is fed by the sensor, but does store at the local processing means (17) data relating to the time that the electrical apparatus (13) has been operating.

b) the local processing means (17) transmitting temporarily stored data to said remote sensor on an event driven basis, transmitting upon a change of the monitored parameter, or upon a communications request from the remote unit (3);

c) the data transmission from the local processing means (17) to the remote unit (3) being sent in a plurality of (e.g three) short bursts in different time domain;

d) the local processing means (17) continually monitoring its own parameter status and reacting as its parameters reach or pass predetermined set points;

e) data integrity of the data transmitted from the local processing means (17) to the remote unit (3) is maintained by way of a multi-level pre-transmission/acceptance check comprising one or more of f) to i);

f) ensuring that the receive signal is continually present for a minimum time (e.g 100 milliseconds);

g) ensuring that the first bit is a particular ASCII character which initialises all receive buffers of the local processing means (17);

h) ensuring that the next bits of information received by the local processing means (17) identify its address;

i) ensuring that the next bits of information contain a predetermined ASCII character and a command digit.

j) ensuring that the data stream received by the remote sensor is at a predetermined speed (e.g 300 baud), any extra or non ASCII characters re-setting the receive buffer of the remote unit (3) to zero and requiring repeat transmission;

k) and in which method the local processing means (17) and remote unit (3) have the ability to communicate digital or analogue data up to a resolution of 10 bit with an accuracy of better than + or - 1% by way of conversion of a typical A to D result into single ASCII characters prior to transmission, digital interpretation taking place in the local processing means (17) and being capable of being read in plain English directly from the point of acquisition with no further requirement for de-coding or translation, so that the data is adapted to be ported directly into proprietary software packaging;

l) and in which local processing means (17) communication with the remote unit (3) is half duplex, each unit having the ability to

transmit or receive data but not simultaneously allowing the local processing means (17) to control loads from a remote command;

m) and the local processing means (17) having the ability to take analogue signals direct from the mains power supply (1) of the electrical apparatus (13), and

n) in which the local processing means (17) provides an analogue R.M.S. reading of load current passing through said electrical apparatus (13).

52. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 in which the the local processing means (17) monitors signals representative of said parameter, but does not store all of the data it is fed by the sensor, but does store at the local processing means (17) data relating to the time that the electrical apparatus (13) has been operating,

53. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 or claim 52 in which the local processing means (17) transmitting temporarily stored data to said remote sensor on an event driven basis, transmitting upon a change of the monitored parameter, or upon a communications request from the remote unit (3).

54. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 or claims 52 to 53 in which the data transmission from the local processing means (17) to the remote unit (3) being sent in a plurality of (e.g three) short bursts in different time domain.

55. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 or claims 52 to 54 in which the local processing means (17) continually monitoring its own parameter status and reacting as its parameters reach or pass predetermined set points.

56. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 or claims 52 to 55 in which ensuring that the data stream received by the remote sensor is at a predetermined speed (e.g 300 baud), any extra or non ASCII characters re-setting the receive buffer of the remote unit (3) to zero and requiring repeat transmission.

57. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 or claims 52 to 56 in which and in which method the local processing means (17) and remote unit (3) have the ability to communicate digital or analogue data up to a resolution of 10 bit with an accuracy of better than + or - 1% by way of conversion of a typical A to D result into single ASCII characters prior to transmission, digital interpretation taking place in the local processing means (17) and being capable of being read in plain English directly from the point of acquisition with no further requirement for de-coding or translation, so that the data is adapted to be ported directly into proprietary software packaging.

58. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 or claims 52 to 57 in which and in which local processing means (17) communication with the remote unit (3) is half duplex, each unit having the ability to transmit or receive data but

not simultaneously allowing the local processing means (17) to control loads from a remote command.

59. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 or claims 52 to 58 in which and the local processing means (17) having the ability to take analogue signals direct from the mains power supply (1) of the electrical apparatus (13).

60. A method of allowing remote monitoring of an electrical apparatus (13) according to claim 50 or claims 52 to 59 in which in which the local processing means (17) provides an analogue R.M.S. reading of load current passing through said electrical apparatus (13).

61. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 60 which comprises connecting the housing means of the electrical apparatus (13) to mounting means which have already been provided

62. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 61 which further comprises providing a housing unit which simply needs to be connected to mains power supply cables (1) in order to provide a working electrical apparatus (13) with the ability to be remotely monitored.

63. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 62 in which allows a number of electrical apparatus (13) to be monitored by a single remote unit (3).

64. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 63 which comprise modifying the signal present on the mains power supply cables (1) to allow the local processing means (17) to communicate with the remote unit (3).

65. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 64 in which the local processing means (17) of a first piece of electrical apparatus (13) may monitor the signal on the mains power supply cable (1) to ensure the local processing means (17) on a different (second) piece of electrical apparatus (13) monitored by the same remote unit (3) as the first piece of electrical apparatus (13) is not communicating with the remote unit (3) (or the remote unit (3) is not communicating with the second piece of electrical apparatus (13)) when the local processing means (17) of the first piece of electrical apparatus (13) communicates with the remote unit (3)

66. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 65 which comprises providing control means in the electrical apparatus (13), which can be controlled by signals from the remote unit (3).

67. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 66 which allows the remote unit (3) to issue global commands which effect all local processing means (17) and/or control means in communication with the remote unit (3).

68. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 67 which allows the

remote unit (3) to issue commands which effect only specific local processing means (17) and/or control means.

69. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 68 which comprises issuing commands from the remote unit (3) which activate each of a plurality of the electrical apparatus (13) in communication with the remote unit (3) in sequence.

70. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 69 in which the remote unit (3) issues commands to turn off (or reduce the current to) electrical apparatus (13) at specific times.

71. A method of allowing remote monitoring of an electrical apparatus (13) according to any of claims 50 to 70 in which the remote unit (3) sounds an alarm when an error message is received from a local processing means (17).

72. A method of allowing remote monitoring of an electrical apparatus (13) accoring to any of claims 50 to 71 in which the electrical apparatus (13) is a light source adapted to produce light.

73. A kit for connecting to a lamp post, the kit comprising a self-contained luminaire housing monitoring means (15) capable of monitoring in use the operation of the lamp and communicating with a remote unit (3).

74. A method of providing a street with street lamps comprising fitting housing units according to the first aspect of the invention to lamp posts already in situ.

75. An item of street furniture comprising a post, or other support structure, and a housing unit, or luminaire, in accordance with any of claims 1 to 49.

76. An item of street furniture according to claim 64 which is a street lamp.

77. A system comprising a plurality of street furniture having a housing unit in accordance with claims 1 to 49 and a remote unit (3) adapted, in use, to receive signals from local processing means (17) of said units.

78. A system according to claim 77 in which the street furniture comprises lamp posts.

79. A system according to claim 77 or claim 78 which is adapted, in use, to control the operation of the electrical apparatus (13) of the items of street furniture.

80. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) comprising a sensor to monitor a parameter of the electrical apparatus (13), a local processing means (17), and a remote unit (3) geographically separate from the electrical apparatus (13); in which the local processing means (17) is adapted to process signals from the sensor and transmit its own signals to the remote unit (3).

81. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to claim 80 in which the local processing means (17) has all of the following features a) to j):

a) the local processing means (17) has a memory which stores data representative of the time the apparatus is operating, but not at least some other data that the local processing means (17) monitors;

b) the local processing means (17) is adapted to transmit signals to the remote unit (3) on an event driven basis, transmitting upon a predetermined change in the status of said parameter, or upon receipt of a communication request;

c) the local processing means (17) has an address which is hardware configurable;

d) the local processing means (17) is adapted to transmit data in short bursts repeated a plurality of times in different time domains;

e) the local processing means (17) is adapted to monitor continually the parameter status and to react to predetermined set points;

f) the local processing means (17) is adapted to operate from a low power supply;

g) the local processing means (17) is adapted to maintain data integrity by way of a multi-level (e.g. five level) pre-transmission/acceptance check before data transmission from the local processing means (17) to the remote unit (3) occurs;

h) local processing means (17) communication is half duplex. the local processing means (17) having the ability to transmit or receive data, but not simultaneously;

i) the local processing means (17) is adapted to control loads from a remote command;

j) the local processing means (17) has the ability to take analogue signals direct from a mains power supply (1) to said apparatus;

82. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to claim 80 in which the local processing means (17) has at least 1 of the features a) to j) specified in claim 81.

83. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to claim 80 in which the local processing means (17) has at least 2 of the features a) to j) specified in claim 81.

84. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to claim 80 in which the local processing means (17) has at least 3 of the features a) to j) specified in claim 81.

85. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to claim 80 in which the local processing means (17) has at least 4 of the features a) to j) specified in claim 81.

86. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to claim 80 in which the local processing means (17) has at least 5 of the features a) to j) specified in claim 81.

87. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to any of claims 80 to 86 in which the local processing means (17) is adapted to communicate digital or analogue data up to a resolution of 10 bit with an accuracy of better than + or - 1% by way of conversion of a typical analogue to digital result into single ASCII characters prior to transmission, digital interpretation taking place in the local processing means (17) and can be read in plain English directly from the point of acquisition with no further requirement for de-coding or translation, the local processing means (17) being adapted to enable the ASCII characters to be ported directly into proprietary software packaging.

88. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to any of claims 80 to 87 in which the address is manually configurable by a user at the site of the electrical apparatus (13).

89. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to any one of claims 80 to 88, in which the local processing means (17) has an address unit which is removable and reconnectable to the same, first, local processing means (17) or a different local processing means (17), thereby enabling a different local processing means (17) to take the address of the first local processing means (17).

90. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to any of claims 80 to 89 in which the electrical apparatus (13) is provided in a housing, and the local processing means (17) is also provided within the housing.

91. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) according to any of claims 80 to 90 in which the electrical apparatus (13) is an item of electrical street furniture, such as a street light or traffic sign, bollard or the like.

92. A method of remote monitoring of an electrical apparatus (13), the method comprising providing a sensor to monitor a parameter of the electrical apparatus (13), providing a remote unit (3) geographically separate from the electrical apparatus (13), at which a user can obtain information about the electrical apparatus (13), and further comprising providing a local processing means (17) at the electrical apparatus (13), the local processing means (17) processing the signals from the sensor before it transmits its own signals to the remote unit (3).

93. A method of remote monitoring of an electrical apparatus (13) according to claim 91 in which the local processing means (17) - remote sensor interface doing all of the following features a) to n):

a) the local processing means (17) monitors signals representative of said parameter, but does not store all of the data it is fed by the sensor, but does store at the local processing means (17) data on the time that the electrical apparatus (13) has been operating;

b) the local processing means (17) transmitting temporarily stored data to said remote sensor on an event driven basis, transmitting upon a change of the monitored parameter, or upon a communications request from the remote unit (3);

c) the data transmission from the local processing means (17) to the remote unit (3) being sent in a plurality of (e.g three) short bursts in different time domain;

d) the local processing means (17) continually monitoring its own parameter status and reacting as its parameter reach or pass predetermined set points;

e) data integrity of the data transmitted from the local processing means (17) to the remote unit (3) is maintained by way of multi-level pre-transmission/acceptance check comprising one or more of f) to i):

f) ensuring that the receive signal is continually present for a minimum time (e.g 100 milliseconds);

g) ensuring that the first bit is a particular ASCII character which initialises all receive buffers of the local processing means (17);

h) ensuring that the next bits of information received by the local processing means (17) identify its address;

i) ensuring that the next bits of information contain a predetermined ASCII character and a command digit;

j) ensuring that the data stream received by the remote sensor is at a predetermined speed (e.g 300 baud), any extra or non ASCII

characters re-setting the receive buffer of the remote unit (3) to zero and requiring repeat transmission;

k) and in which method the local processing means (17) and remote unit (3) have the ability to communicate digital or analogue data up to a resolution of 10 bit with an accuracy of better than + or - 1% by way of conversion of a typical A to D result into single ASCII characters prior to transmission, digital interpretation taking place in the local processing means (17) and being capable of being read in plain English directly from the point of acquisition with no further requirement for de-coding or translation, so that the data is adapted to be ported directly into proprietary software packaging;

l) and in which local processing means (17) communication with the remote unit (3) is half duplex, each unit having the ability to transmit or receive data but not simultaneously allowing the local processing means (17) to control loads from a remote command;

m) and the local processing means (17) having the ability to take analogue signals direct from the mains power supply (1) of the electrical apparatus (13); and

n) in which the local processing means (17) provides an analogue R.M.S. reading of local current passing through said electrical apparatus (13).

94. A method of remote monitoring of an electrical apparatus (13) according to claim 92 in which the local processing means (17) has at least one of the features a) to n) specified in claim 93.

95. A method of remote monitoring of an electrical apparatus (13) according to claim 92 in which the local processing means (17) has at least 2 of the features a) to n) specified in claim 93.

96. A method of remote monitoring of an electrical apparatus (13) according to claim 92 in which the local processing means (17) has at least 3 of the features a) to n) specified in claim 93.

97. A method of remote monitoring of an electrical apparatus (13) according to claim 92 in which the local processing means (17) has at least 4 of the features a) to n) specified in claim 93.

98. A method of remote monitoring of an electrical apparatus (13) according to claim 92 in which the local processing means (17) has at least 5 of the features a) to n) specified in claim 93.

99. A method of remote monitoring of an electrical apparatus (13) according to claim 92 in which the local processing means (17) has all of the features a) to n) specified in claim 93.

100. A method of remote monitoring of an electrical apparatus (13) according to any of claims 92 to 99 in which the remote unit (3) obtains data in the field from a plurality of local processing means (17)'s, and has the ability to have data manually entered into it in the field, and has a visual display unit adapted to display information to a user, and maintains a log with data and time recorded for data transmitted to it from the local processing means (17)'s.

101. A method of remote monitoring of an electrical apparatus (13) according to Claim 100 in which the remote unit (3) has built in software tools to process the data it receives.

102. A network of electrical apparatus (13) comprising a plurality of electrical apparatus (13), each of which has a local processing means (17) in accordance with claims 80 to 91, and a remote unit (3) in communication via power supply cables with the apparatus, the network being adapted to operate in accordance with the method of any of claims 92 to 101.

103. A housing unit substantially as described herein with reference to the accompanying drawings.

104. A method of allowing remote monitoring of an electrical apparatus (13) substantially as described herein with reference to the accompanying drawings.

105. A kit for connecting to a lamp post substantially as described herein with reference to the accompanying drawings.

106. A method of providing a street with street lamps substantially as described herein with reference to the accompanying drawings.

107. An item of street furniture substantially as described herein with reference to the accompanying drawings.

108. A system substantially as described herein with reference to the accompanying drawings.

109. Monitoring apparatus adapted, in use, to monitor electrical apparatus (13) substantially as described herein with reference to the accompanying drawings.

110. A method of remote monitoring of an electrical apparatus (13) substantially as described herein with reference to the accompanying drawings.

111. A network of electrical apparatus (13) substantially as described herein with reference to the accompanying drawings.

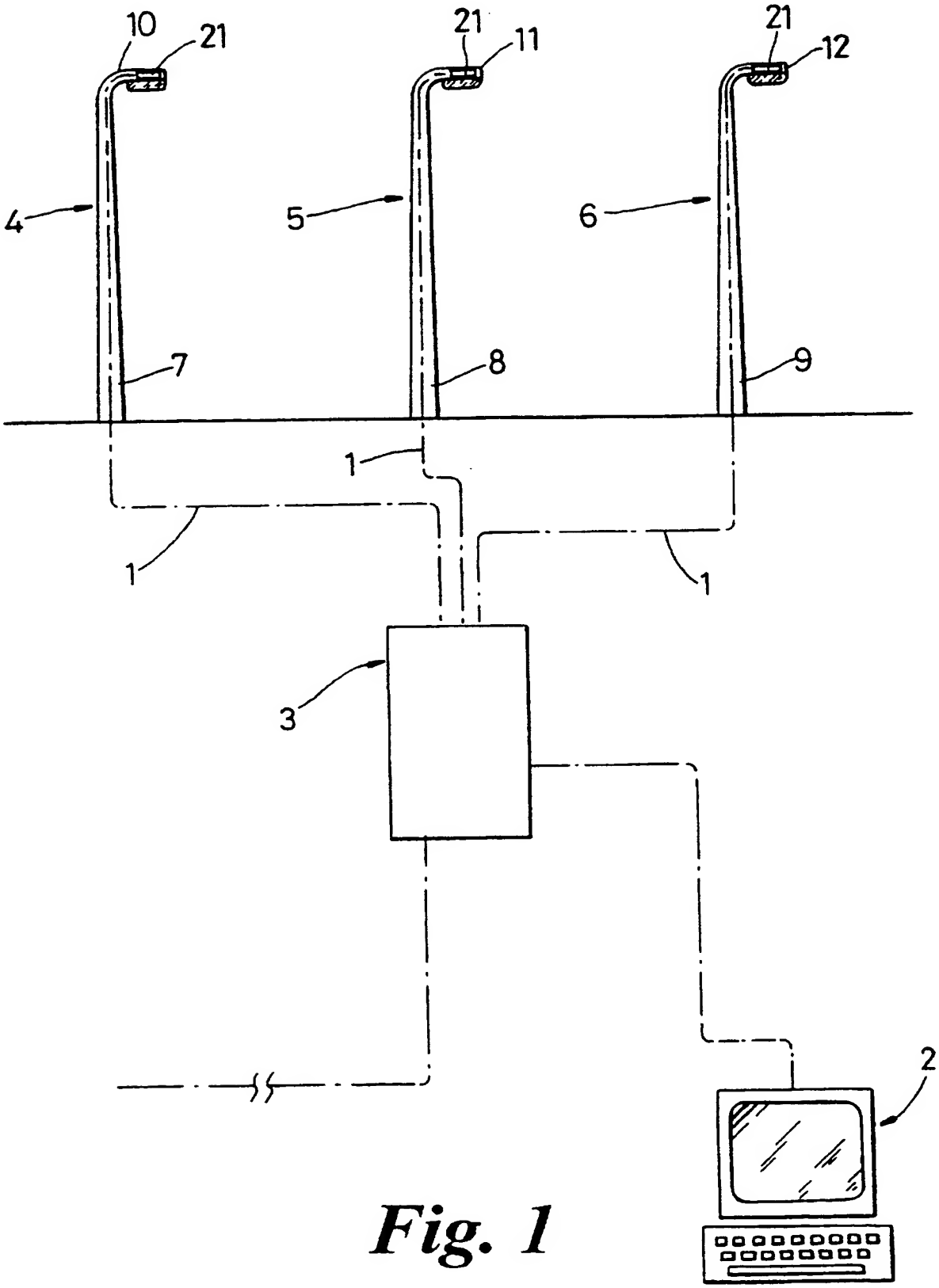

Fig. 1

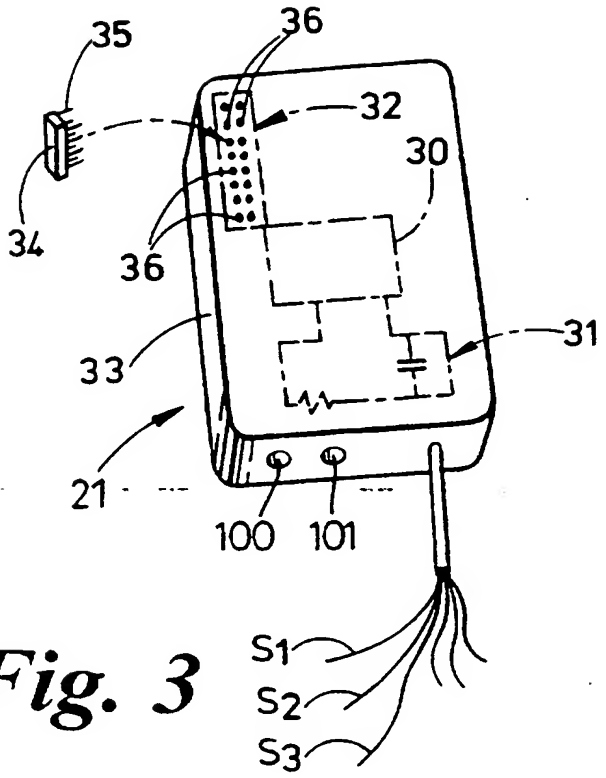

Fig. 3

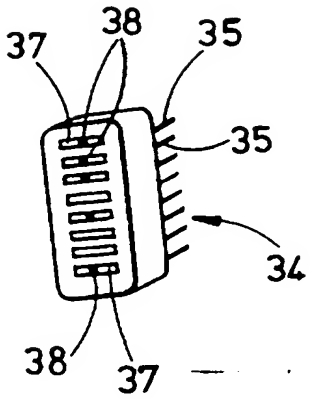

Fig. 4

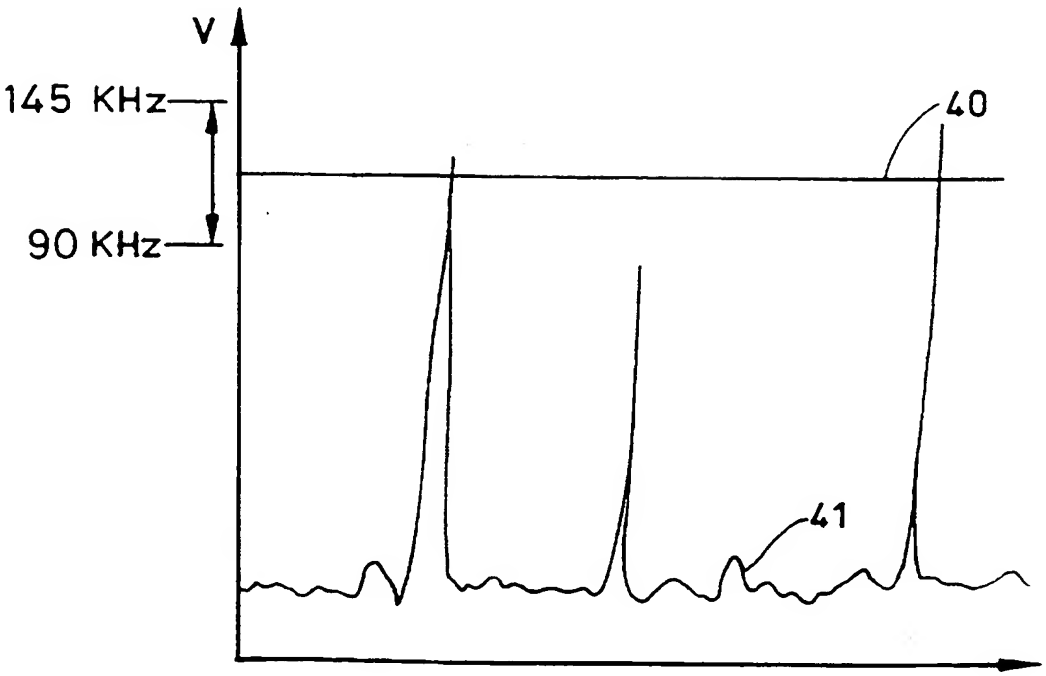

Fig. 2

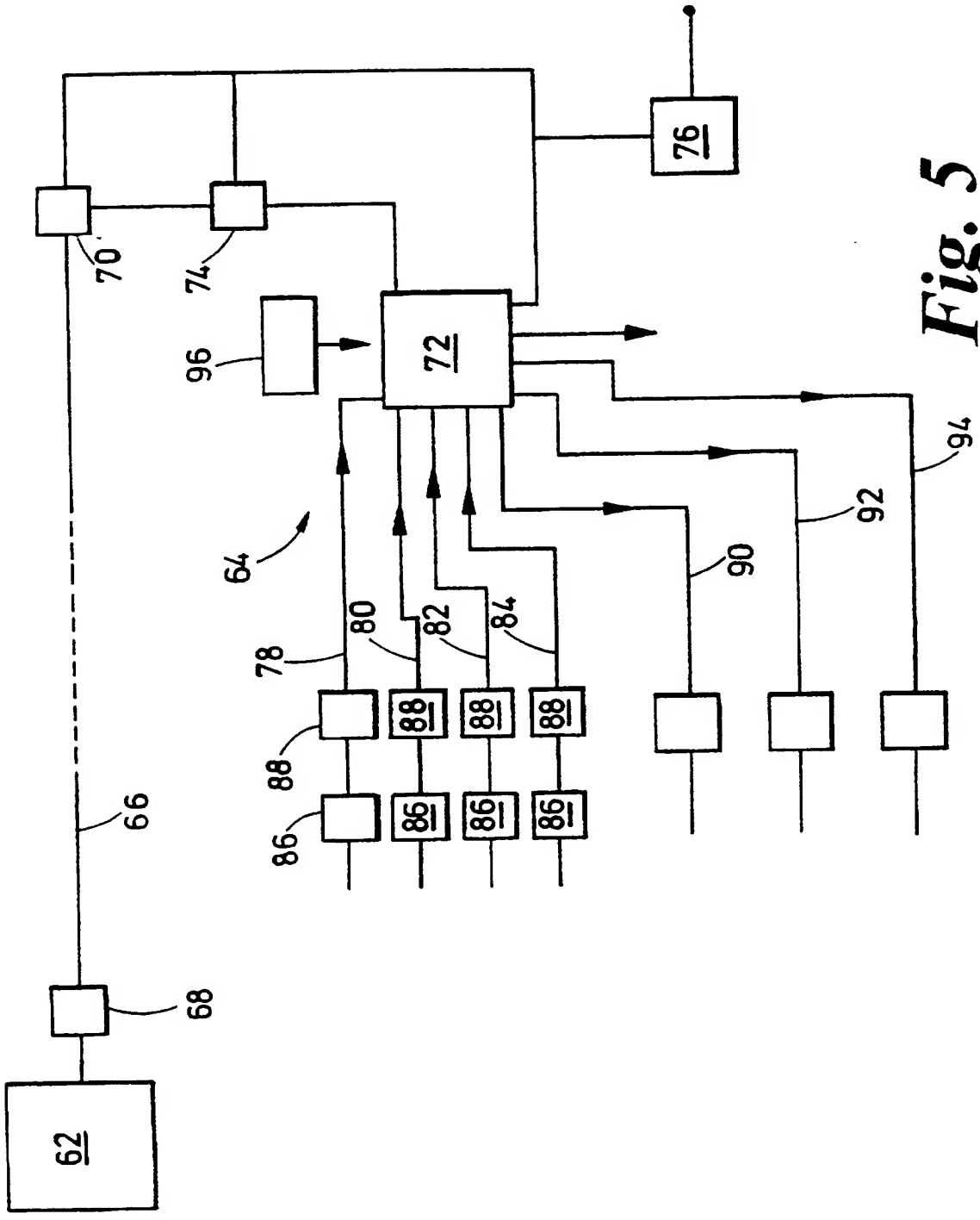

Fig. 5

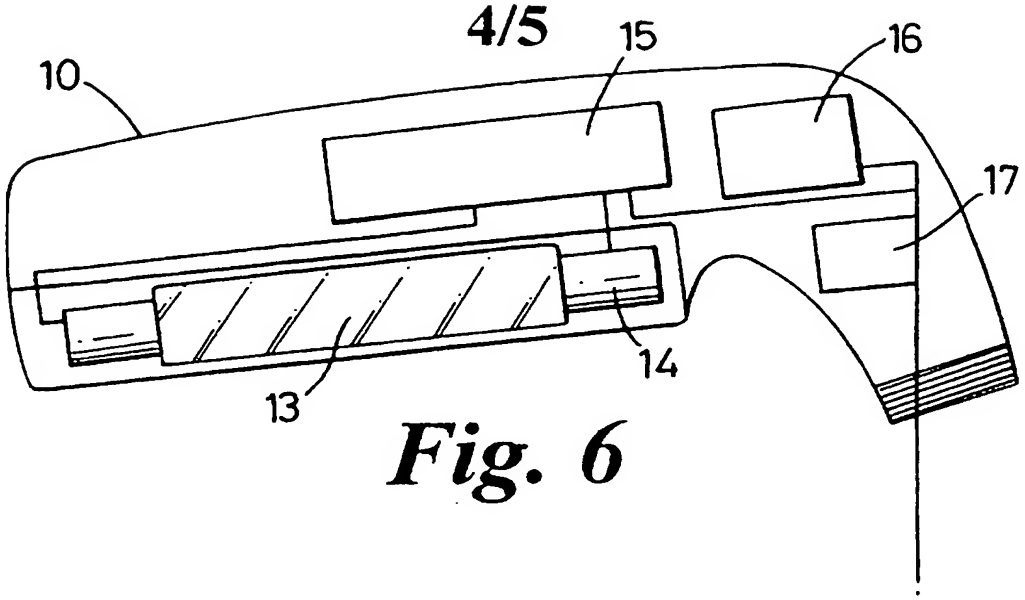

Fig. 6

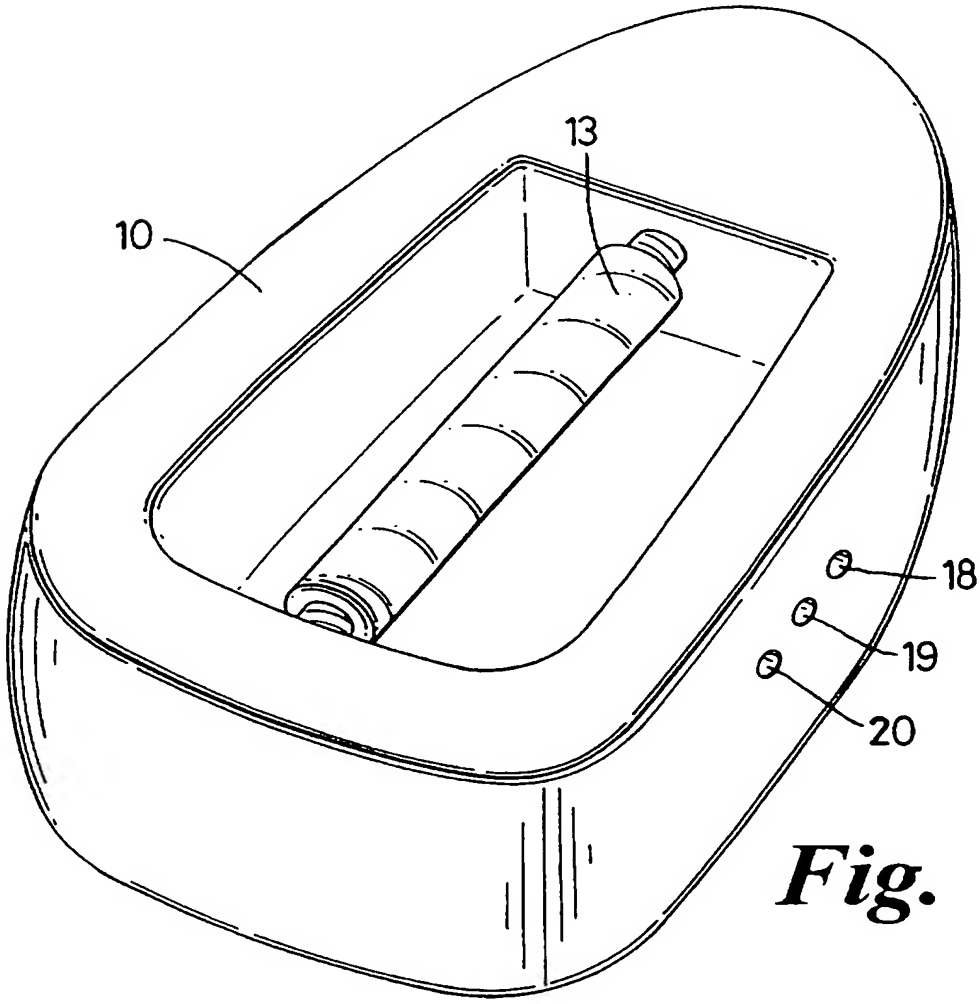

Fig. 7

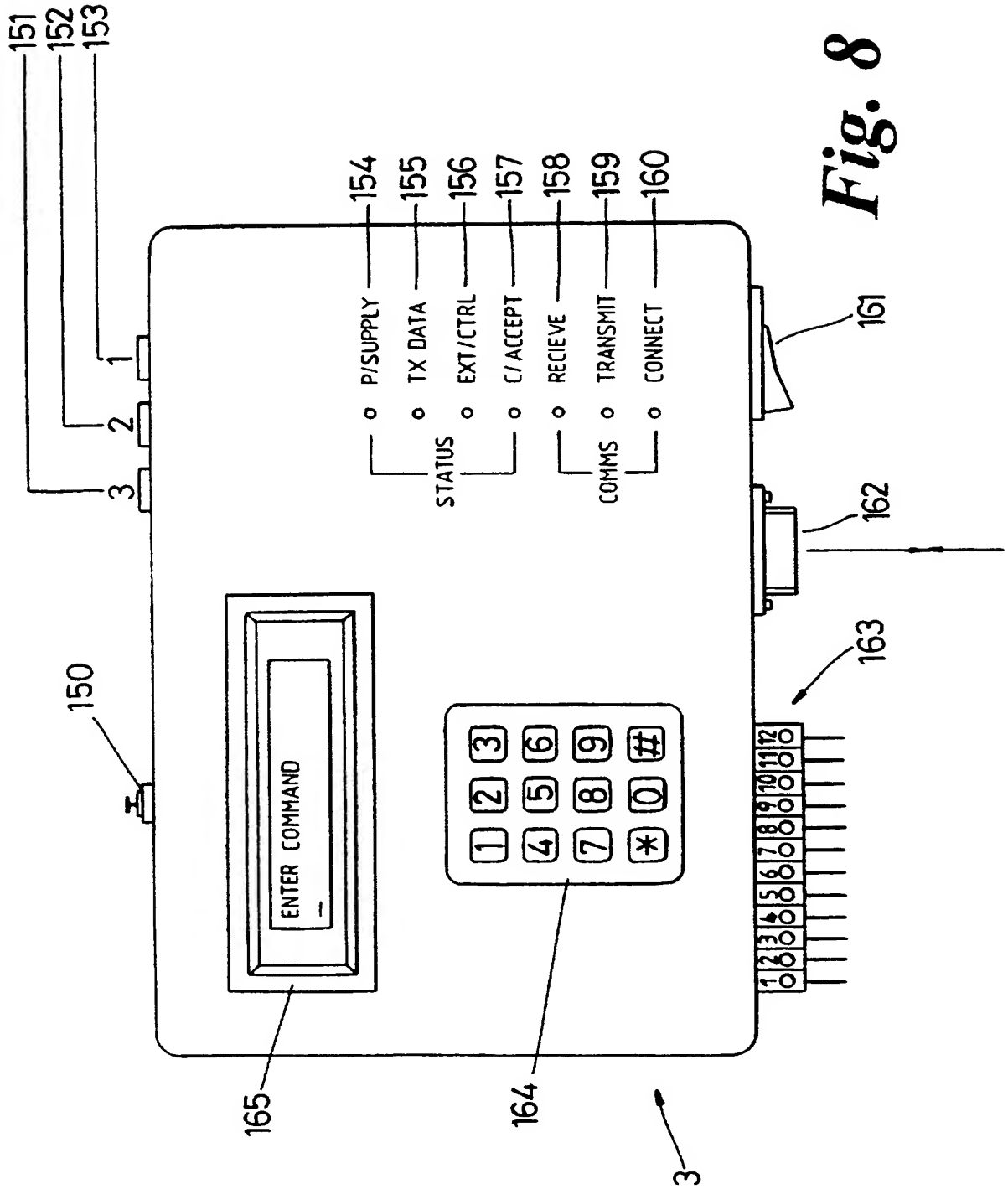

Fig. 8

INTERNATIONAL SEARCH REPORT

[redacted]onal Application No
PCT/GB 97/01870

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G08B25/06 G08C25/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G08B G08C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 291 993 A (PTF CONSULTANTS LTD) 7 February 1996 cited in the application see the whole document	1,3-5,7, 8,10-12, 14-24, 26,27, 30,31, 35-50, 52,53, 55,58, 59, 61-64, 66,72-80
X		82-84, 88-92, 94-96, 102-111
Y		2,6,9,54
A		51,81,93

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
22 September 1997	08. 10. 97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	**Authorized officer** Wanzeele, R

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INTERNATIONAL SEARCH REPORT

Inte[illegible] Application No
PCT/GB 97/01870

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 31 19 119 A (BOSCH GMBH ROBERT) 9 December 1982 see page 7, line 12 - page 12, line 25; figures 1-5	2,6,9,54
Y	US 4 091 361 A (EICHELBERGER CHARLES W ET AL) 23 May 1978 see abstract	2,9
Y	EP 0 568 394 A (TOKYO SHIBAURA ELECTRIC CO) 3 November 1993 see claims 1-5	2,9

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 97/01870

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2291993 A	07-02-96	NONE	
DE 3119119 A	09-12-82	NONE	
US 4091361 A	23-05-78	NONE	
EP 0568394 A	03-11-93	JP 6269056 A	22-09-94
		JP 5308682 A	19-11-93
		JP 6133377 A	13-05-94
		CA 2095185 A	31-10-93

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